REMARKS/ARGUMENTS

Reconsideration of the application is respectfully requested.

In response to the objection to claim 38, the misspelling of "laser" has been corrected.

The rejection of claims 26-28, 33-38 and 62 under 35 U.S.C. 102 as allegedly anticipated by Furuyama et al. '426 is respectfully traversed.

The examiner asserts that Furuyama discloses a semiconductor laser diode and a feedback section for providing wavelength selective feedback to the laser diode wherein the feedback section comprises a zone plate device. However, with respect, Furuyama simply does not even disclose feedback to any laser.

Feedback in ordinary English (and in this technology) means an output is fed back to an earlier point in the process that created the output, e.g., back to where it came from. This may be either directly or after processing. There is no feedback to a laser diode in Furuyama.

The examiner refers to "Fig. 3a Character 120" for the laser diode and the applicant agrees that it is indeed a laser diode. But there is no feedback to that laser. Without feedback, the whole point of the applicant's invention is lost since the use of a zone plate device to provide both wavelength control in feedback and an imaging optic. The applicant's device gives tunable feedback with all the advantages of no moving parts, range of tunability and compatibility, optionally using a waveguide, to deliver the optical beam between the laser diode and the zone plate device. All of the arrows in any of the

figures of Furuyama showing optical radiation travelling with respect to the laser 120 are directed away from it. There is no feedback to the laser diode 120.

The whole point of Furuyama is to pick off radiation transmitted by the laser diode 120 at interconnecting elements 124 -- not to put anything back into it. Laser diode 120 is mentioned in column 10, starting at line 62, in the description of Figure 3a. The laser 120 is a surface emitting laser with an electrical input 121 and an ordinary optical diverging lens 123 (apparently mis-referenced as 122 in the text, this being shown in Figure 3a as the active region of the laser 120). The lens 123 delivers the laser output to the optical interconnecting elements 124 and ultimately to the light-receiving element 127. There is no optical input to the laser 120 shown at all.

The laser 120 does not appear in any other figure and is not at any point described as having any form of feedback.

The examiner refers to **<u>column 7, lines 13-28</u>** and Fig. 8a for the "feedback section". To quote this cited passage in full:

> *"Further, each optical interconnecting element can be easily made and can have excellent heat radiating property since its back electrode is specifically patterned, forming a surface lens. Since the resonator interposed between the light-receiving surface and light-emitting surface of each optical semiconductor element has an optical thickness which is an integral multiple of half the wavelength to be selected, <u>the returning light is suppressed</u>. As a result, the optical semiconductor element has a high operating efficiency and a low power consumption. Moreover, provided with an optical resonator which is interposed between the light-receiving surface and the light-emitting surface and which has an effective length continuously changing in a plane, each optical semiconductor element has a continuously varying resonance wavelength."* [emphasis added]

The applicant does not find this passage clear but does note that it specifies that returning light is suppressed. There is no feedback. Suppression of returning light is mentioned several times in Furuyama. Feedback is returning light. You don't suppress it if you are trying to provide feedback.

This passage is only about the optical interconnecting elements. These appear in different embodiments in several of the figures. None of them provides feedback to a laser. As it says in the passage, they each have a light-receiving surface and a light-emitting surface. That is, light comes in at one place and leaves at another. For instance in Figure 3a, as the arrows demonstrate, the light comes in from the lefthand side of the interconnecting elements 124 and leaves from the righthand side. There is a laser with a resonant structure in some embodiments of the interconnecting elements but there is no feedback.

The Examiner further refers to Figure 8a as being relevant to a feedback section. Figure 8a really couldn't be clearer. There is input light 178 and output light 179 with a conventional wave-selecting filter in between. To quote **column 17, lines 40 to 47**:

> *"In operation, multiplied input light 178 consisting of components of various wavelengths is applied to one side 174a of the filter. Of these components, only those having the Bragg wavelength determined by the interlattice interval and refractive index of the diffractive lattice 172 are selected and output as output light 179 from the other side 174b of the wavelength-selecting filter."*

There is no feedback and no zone plate device in Figure 8a. There is a grating but it is a distributed Bragg filter with lattice spacing, these being rectilinear, extending

generally in the same direction as the optical beam. Conversely, the grating of a zone plate device is non-rectilinear, often circular for instance, and it extends across the beam, not along it.

The Examiner refers to the applicant's specification for a definition of the feedback section. The applicant assumes that the examiner's reference to page 6, lines 20-25 is intended to be a reference to page 4, lines 20-25. The passage then in question is:

> *"For instance, according to an aspect of the present invention, there is provided a tunable optical source comprising a laser diode and a feedback element for providing wavelength selective feedback to the laser diode, said feedback element comprising a zone plate device and control means for controlling the wavelength of the feedback to the laser diode, said control means comprising means to apply an electric field to material of the zone plate device."*

This unequivocally states that the feedback element provides feedback to the laser diode. Furuyama does not even have feedback, let alone use a zone plate device to provide it.

Even if the Examiner were to argue that the output of the Figure 8a device, or any other interconnecting device disclosed in Furuyama, could be fed back to a laser and that all one needs is wavelength selectivity, such an argument would completely miss the point that the applicant's zone plate device offers a physical construction which has significant advantages. In manufacturing terms, the applicant's device offers two devices in one: the grating gives both wavelength control and an imaging optic. It offers few

physical interfaces to the optical radiation in feedback, physical stability in use and the potential for easy coupling to Fabry-Perot lasers.

The Examiner also refers to Figure 8a, column 7 lines 13-28 and column 17 lines 14-59 for the words "wavelength selective". It isn't clear whether the Examiner is claiming these passages and Figure 8a show wavelength selective feedback or just wavelength selection per se. However, the applicant is not claiming wavelength selection per se and in the passage quoted above is quite clearly talking about *"a feedback element for providing wavelength selective feedback to the laser diode"*.

Figure 8a of Furuyama merely shows a conventional wave-selecting filter. This is stated at column 17, lines 27, 28. No feedback is shown or mentioned. Without feedback, none of the advantages of the applicant's device discussed above are obtained.

The passage in column 7 referred to by the Examiner is already quoted above. Column 7 seems to be referring to the third and fourth embodiments of the invention disclosed in Furuyama. It discusses a resonator interposed between the light-receiving surface and light-emitting surface of each optical semiconductor element. The resonator has an optical thickness which is an integral multiple of half the wavelength to be selected, so that <u>the returning light is suppressed</u>. This is clearly nothing to do with feedback. Further on, column 7 says:

> *"Moreover, provided with an optical resonator which is interposed between the light-receiving surface and the light-emitting surface and which has an effective length continuously changing in a plane, each optical semiconductor element has a continuously varying resonance wavelength."*

This is thought by the applicant to be a reference to the fourth embodiment of the invention disclosed in Furuyama. The applicant thinks this because the description of the fourth embodiment starting at column 21 includes the similar passage:

> *"More specifically, this semiconductor element has a light-amplifying layer which defines an effective resonator length spatially continuous in a plane, and has a continuous resonance wavelength."*

But in all the embodiments described from column 17 onwards, starting with the third embodiment:

i) all of them are intended to suppress returning light and therefore have nothing to do with feedback; and

ii) none actually shows a zone plate device of any sort, although presumably there may be a grating lens provided to shape the beam between interconnecting elements (further discussed below).

These are all interconnecting elements with resonant layered features to select the wavelength of optical radiation transmitted onwards. Examples of references to the suppression of returning light are:

- Column 17, lines 48 to 59 where it points out the problems with returning light which are optical energy loss and noise to the preceding wavelength-selecting filter
- Column 18, lines 25,26
- Column 19, lines 38 to 43

There are certainly grating lenses disclosed in Furuyama which perhaps support the description of the interconnecting elements 124, 141 as zone plate devices. They are used as lenses to shape the beam in passing from one interconnecting element to the next. They are not used either in feedback to any device or in wavelength control. These zone plate devices are shown in Figures 3b, 4, 5a, 6b, 7a and 7b, where they are referenced "111" except in Figures 7a and 7b where the electrode 159 provides a Fresnel-type lens.

In the description of Figure 3b, at lines 42 to 45 of column 10, the lens 111 is said to be:

> *"designed to focus an input beam at a point at half the distance between the two boards to be connected by the optical interconnection device."*

In practice, this grating lens 111 has quite a complicated structure, described with reference to Figure 4 in column 11, lines 38 through to column 12, lines 1 to 14. At no point in Furuyama however does an interconnecting element provide feedback and at no point does a grating lens 111 provide wavelength control. The grating lens 111 just has an optical focussing effect.

In relation to Figures 5a and 6b, the grating lens is referred to at lines 63 to 68 of column 13 and lines 1 to 6 of column 14. Again, there is no feedback and no wavelength control by the grating lens 111.

In relation to Figures 7a and 7b, here we are discussing the back electrode 159. Description of this is mainly given starting at line 58 of column 15 through to line 44 of column 16. Again there is no feedback. The back electrode 159 is one of two electrodes

present to drive gain in the device which is a light amplifier having an active layer 152. Although the back electrode 159 has arcuate openings allowing the passage of light of specific wavelengths, it must presumably be designed to allow passage of the light which it receives. The light it receives comes from a distributed Bragg structure and it is this which necessarily controls the wavelength reaching the back electrode 159.

Claim 62 has been amended to distinguish more clearly from the lenses of Deacon Figures 54 and 58. The grating in Deacon's zone plate device extends right through the device from an input facet to an output facet and the electrodes 1542, 1544 are necessarily positioned on the input and output facets, right across the path of the optical beam. In contrast, because of the different nature and construction of the applicant's zone plate device, the electrodes extend along the sides of the device, out of the path of the optical beam and between the input facet and the output facet, not across them. Claim 62 has been amended by a limitation to the arrangement of the electrodes to extend <u>between</u> the two facets.

With these fundamental deficiencies vis-à-vis independent claim 26, dependent claims 27, 28 and 33-35 are also clearly patentably distinct -- for even additional reasons as reflected by the additional recitations of these dependent claims.

Independent claim 36 has been amended in a similar fashion so that it is the grating of the zone plate device that controls wavelength and feedback. Claim 37 adds yet further patentable distinctions.

Independent claim 38 has also been amended to require electrical control of delivered frequency by means of the grating of a zone plate device. Clearly, Furuyama shows neither wavelength nor frequency control by electrical tuning of a grating in a zone plate device.

Independent claim 62 has also been amended to clarify the requirement of grating-based control of optical radiation using a zone plate device, in this case, intensity switching. Claim 62 also defines a particularly useful structure where the switching occurs at a facet of the zone plate device, thus making embodiments easy to assemble and manufacture. Dependent claim 63 adds yet further patentable distinctions to the claimed invention.

Although the Office Action is somewhat ambiguous as to whether or not dependent claims 43 and 44 have been rejected as allegedly anticipated by Furuyama (e.g., see the first sentence on page 3 of the Official Action does not include any mention of these claims). In any event, claims 43 and 44 depend directly or indirectly from independent claim 26, and the major fundamental deficiencies of Furuyama with respect to independent claim 26 have already been discussed above. Accordingly, it is not believed necessary at this time to discuss the further deficiencies of this reference with respect to these additional dependent claims.

Similarly, the outstanding Office Action is ambiguous as to whether or not claims 45-51 and 58 were intended to be included within the rejection based on alleged anticipation. In any event, these claims are also directly or indirectly dependent from

independent claim 26 that has already been discussed above. Once again, it is not believed necessary at this time to detail the further deficiencies of Furuyama with respect to the additional recitations of these additional dependent claims.

The rejection of claim 28 under 35 U.S.C. § 103 as allegedly made "obvious" based on Furuyama '426 in view of Lehovic '360 is also respectfully traversed.

The fundamental deficiencies of the primary Furuyama '426 reference with respect to parent claim 26 have already been noted above.

The Examiner states that "*Furuyama discloses the claimed invention except for the zone plate device is electro-optic.*" As discussed above, Furuyama shows no feedback and neither wavelength nor frequency control by electrical tuning of a grating in a zone plate device. Lehovic also supplies none of these things.

Lehovic discloses the use of a zone plate device but simply as an optically focussing lens. Although "*electro-optical*" structures are mentioned, Lehovic was written over thirty years ago. "*Electro-optical*" in the Lehovic context only means that there is a relationship in the device between electrical and optical energy. For example, Lehovic calls Figure 5 "*an integrated electro-optical structure*" (column 4, lines 42-43) because it has in it a photoelectric element having a PN junction 43 in a semiconducting wafer 41. This is described in column 4 at lines 16 to 41. The electro-optic effect referred to by the applicant is a different and far more specific effect based on the Pockels coefficient and discussed in some detail under the heading "Electro-optic effect" in the applicant's patent specification.

Lehovic points out (column 4, lines 37-41) that the "*advantage of using the zone plate optics...... lies in the increased intensity of the incident beam at the photoelectric element 42 due to the focussing action of the zone plate.*" Thus the role of the zone plate structure is simply that of an optical lens.

Again and again, Lehovic emphasises the importance of using monochromatic light with the zone plate device. The following are specific examples:

- Column 2, lines 20 to 23
- Column 3, lines 30 to 34
- Column 6, lines 26 to 30

This is because the zone plate device in Lehovic is being used as a lens to receive radiation and to focus it onto another structure in a fixed location. There is no feedback, no wavelength selection and no tuning and the arrangement of Lehovic is unrelated to embodiments of the applicant's invention covered by claim 28, either alone or in combination with Furuyama.

The rejection of claims 29-32 under 35 U.S.C. § 103 as allegedly being made "obvious" based on Furuyama '426 in view of Deacon '809 is also respectfully traversed.

First of all, these claims depend directly or indirectly from independent claim 26, and the fundamental deficiencies of the primary Furuyama '426 reference with respect to that claim have already been noted above.

The Examiner asserts that:

> *"Furuyama discloses the claimed invention except for zone plate device comprises strontium barium niobate (SBN:75) and the zone plate device comprises a piece of said material, the piece of material having zone plate elements on a first facet thereof and said predetermined location coinciding with a second facet thereof. It would have been obvious at the time of applicant's invention, to combine Deacon of teaching a zone plate device comprises strontium barium niobate (SBN:75)........"*

Deacon, in Figures 54 and 58, shows a zone plate device used as an optical lens for focussing monochromatic light. Figure 41 shows two lenses 1380, 1381 which might be zone plate devices but again these are just for focussing light in the manner of an optical lens.

Deacon is concerned with creating gratings within electro-optic material by using poled structures in the material. The poled structures are arranged in domains and act as gratings when an electric field is applied. In the zone plate devices of Deacon, the gratings extend right through the device from input facet to output facet and the devices are thin in order to perform effectively as a lens. Significantly, because of the nature of the grating, the electrodes have to be across the path of a beam to be focussed. Transparent electrodes 1542, 1544 are used and they extend right across the input and output sides of the grating lenses. This is a significant disadvantage since there are then additional interfaces and materials in the path of optical radiation being focussed. This inevitably introduces losses and scattering or dispersion.

The applicant does not understand the Examiner's reference to strontium barium niobate (re claims 29-31) in the context of Deacon. Although the applicant has scanned the whole of this very long document, there appears to be no mention at all of strontium

barium niobate, let alone the particular variant SBN:75 which is a preferred form of SBN described in the applicant's specification. The relevant material most referred to in Deacon is lithium niobate. The applicant begs forgiveness if SBN is indeed mentioned in Deacon but would ask that, in accordance with standard USPTO practice, the Examiner point out exactly the relevant section if this position is maintained.

As discussed above, Furuyama shows no feedback and neither wavelength nor frequency control by electrical tuning of a grating in a zone plate device. Deacon does mention feedback to a laser but it is performed by a periodically poled reflector, not by a zone plate device. There is no feedback using a zone plate device in Deacon. The zone plate devices in Deacon operate simply as lenses with monochromatic light sources. As discussed in column 80 at lines 19 to 21 and line 39, the input to the zone plate device is "a given color". This device in Deacon is not intended to select a colour. It is agreed that Deacon refers to tunable devices and to feedback but <u>not in the context of a zone plate device.</u> It would be neither obvious nor effective to introduce a device as shown in Deacon into the Furuyama arrangement since Furuyama does not deal with feedback and the device shown by Deacon is not for use in tuning and would introduce poor optical performance in feedback due to the additional interfaces and electrode materials to the path of the beam being dealt with.

The applicant is further confused by the reference of the Examiner to "the piece of material having zone plate elements on a first facet thereof and said predetermined location coinciding with a second facet thereof" in the discussion on page 10 of the office

action. This is shown in neither Furuyama nor Deacon. It is a particularly convenient form of the applicant's invention but it is not shown in the prior art. Since the prior art is doing a quite different job, it would not be an at all obvious or effective variation from what is actually shown in the prior art either.

The rejection of claim 38 under 35 U.S.C. § 103 as allegedly being made "obvious" based on Furuyama '426 in view of Barrett '188 is also respectfully traversed.

Somewhat inconsistently, the Examiner earlier asserted that claim 38 was anticipated by Furuyama '426 alone. As already noted above, this ground of rejection is clearly erroneous due to many fundamental deficiencies of the Furuyama '426 teaching.

Barrett simply shows another zone plate device used as a lens. It does not supply any of the multiple deficiencies of Furuyama. Furthermore, the addition of a mode hop control device to the Furuyama arrangement would be irrelevant in view of the already noted multiple deficiencies of Furuyama.

The rejection of claims 52-57 and 59-61 under 35 U.S.C. § 103 as allegedly made "obvious" based on Furuyama '426 in view of Faris et al. '233 is also respectfully traversed.

Once again, as already noted above, all of these claims depend directly or indirectly from independent claim 26, and the fundamental deficiencies of Furuyama '426 have already been noted above. The addition of a mode hop control device to the Furuyama arrangement would be irrelevant in view of the multiple deficiencies of Furuyama and thus Faris actually adds nothing of relevance (even if it be assumed

arguendo that there is any suggestion that these two references for the combination being proposed by the Examiner).

The Examiner's attention is drawn to new claims 64-66 which depend directly or indirectly from claim 62 and are believed to add yet further patentable features to that particular claimed invention.

Accordingly, this entire application is now believed to be in allowable condition, and a formal notice to that effect is respectfully solicited.

Respectfully submitted,

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